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The Integration Model of Agricultural Products Distribution Resource Based on Grid Management

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Abstract: Integrated Grid Management is proposed as a model to remodel and integrate the current system of dispersed computational resources for agricultural products distribution. Using FlexSim to simulate the model, the effectiveness of this alternative grid management model is demonstration through reduced queue length, waiting time and better resource utilization. Finally, suggestions on the policy level were put forward regarding how to realize improved efficiency of logistics resources utilization and thus, the sustainable development of the agricultural logistics sector.

Keywords: Agricultural Products, Grid Management, Resource Integration

1. Introduction

Currently there are many unreasonable facts in the distribution system of agricultural products, such as scattered pattern of resource distribution, excessive allocation of distribution resources or incorrect distribution, which resulted in the consistently high costs and circulation losses of agricultural products distribution. The traditional and outdated logistic distribution mode of agricultural products has been increasingly unable to meet the demands of social consumers and suppliers for diverse agricultural products. And the Joint Distribution was introduced distribution of agricultural products, which can form large-scale efficiency and reduce logistics costs through large-scale operations, as well as improve the efficiency of logistics resources. But the key point of Joint Distribution is how to integrate the distribution resources which involves many parts in the distribution process. So this paper mainly discusses the issue of distribution resource Integration in the joint distribution of agricultural products to share resources and work together by building the grid management distribution system, and how to reduce the logistics costs and the prices of agricultural products.

2. Classification and Characteristics of Distribution Resources of Agricultural Products

Generally, the distribution resources involve all the sum of investment to achieve distribution in the system, including the completion which distribution services and distribution operations depend on. Such as funds, technology, knowledge, information, personnel, places, equipment and facilities, etc. And in broadly speaking, distribution organization resources and distribution system resources are also included.

In general, the distribution resources of agricultural products are mainly the following categories:

(1) Distribution Facilities resources： The place for achieving distribution, such as distribution centers, distribution centers, logistics centers and warehouse, etc.

(2) Distribution equipment resources： The logistics equipment supports for picking, shipping, packaging during agricultural products distribution, such as truck.

(3) Distribution Human Resources: Refers directly engaged in agricultural products distribution business

operations and personnel management activities, including loading and unloading personnel, information processing personnel, distribution equipment operators and distribution activities at all levels of managers.

(4) Distribution Technical Resources: Mainly refers to the key methods and techniques support for the distribution system construction and distribution activities.
(5) Distribution Financial Resources: Mainly refers to the financial support that distribution of jobs in agricultural activities relied on, such as staff salaries, facilities and equipment rental and energy costs, etc.
(6) Distribution Information Resources: Refers to the various types of information can generate and operation of a direct or indirect impact on the distribution activities, the typical distribution information resources, including information distribution needs.
(7) Distribution organization resource: it is the main body of the development and management of other resources.
(8) Distribution system resources: it refers to the formal and informal rules that affect the distribution activities, whose main forms are government policies and regulations.

Agricultural products distribution organization is more dispersed, with low degree of organization and unshared information resources. In resources integration, people shall effectively organize all kinds of resources in different regions, different enterprises, different organizations and individuals to form a logistics distribution system in accordance with its characteristics and processes. And the end user can obtain information from the Internet as easy access to a variety of logistics services, and the specialized services solutions for specific logistics demand with the support of logistics resources grid management.

3. Grid Management

3.1. Grid and Grid Management

Advances in networking technology and computational infrastructure make it possible to construct large scale high-performance computational grids that provide dependable, consistent and pervasive access to high-end computational resources [1]. These environments have the potential to change fundamentally the way we think about resources management, as our ability to compute will no longer be limited to the resources we currently have on hand.

Grid management refers from grid computing, in order to ultimately achieve the integration of resources, the management objects can be divided into several grids according to certain criteria, and get the use of modern information technology and coordination mechanisms between the various grid to share the resource among each grid, so that improving the efficiency of modern management, achieving full sharing of computing resources, storage resources, data resources, information resources, software resources, communication resources, knowledge resources, expert resources and etc.

3.2. Grid Management Architecture

The Grid Management Architecture can be called the Five-Level hourglass Architecture of the grid, which focuses on the anatomy of internal structure. Centered on the "protocol", end users and virtual organizations can negotiate to use the resources through the protocol mechanism, so as to share resources.

Network protocol is divided into five levels as shown in Figure 1:

(1) Structural Layer: it refers to the specific resources, including physical resources and logic resources. Such as computing resources, storage systems, directories, network resources and distributed file systems, distributed computing pool, computer and other groups.
(2) Link Layer: The function of this layer is to realize the security of lower resources which can connect and operate with each other. This layer defines the core protocol of secure communication and authentication authorization control in grid.
(3) Resource Layer: It’s the callable resources it the database, such as vehicles and warehouse can be dispatch.
(4) Collection Layer: It’s centralized to coordinate multiple resources existing in a single form, putting the controlled resources submitted by the resource layer together, so as to be shared and invoked by the application program of virtual organizations.
(5) Application Layer: Individual sites are not constrained in their choice of resource management tools.

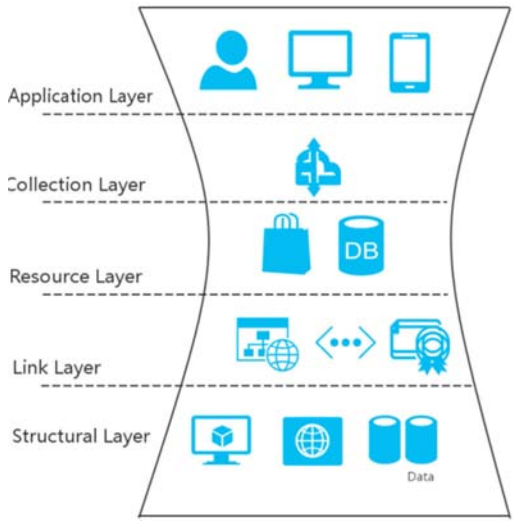

Fig. 1. Grid Management Architecture.

3.3. The Rationality of Grid Management’s Application in the Resources Integration for Agricultural Product

Grid management can be understood as the developed knowledge system to solve complex problems, which includes both a set of advanced information technology and new management thoughts. It's a significant administrative system with the integrated various resources by the support of information technology. Grid Theory can dynamically manage resource from each gird, allocate resource and manage process to achieve "unified service, resource sharing and business collaboration" from an overall perspective. The basic characteristic of Grid management is consistent with the goal we try to achieve in the integration of resources, so that quoting the Grid management into agricultural products distribution resource integration is feasible.

3.4. Distribution Resource Integration Model for Agricultural Product

According to the theory and architecture of grid management, the distribution of agricultural resource integration model structure [2] is divided into 4 parts (illustrated in Figure 2): 1) User Layer; 2) User Proxy; 3) GRAM (Resource allocation and process management) Protocol; 4) Resource Layer. And the system provides a standard network-enabled interface to local resource management systems. Hence, computational grid tools and applications can express resource allocation and process management requests in terms of a standard API, while individual sites are not constrained in their choice of resource management tools.

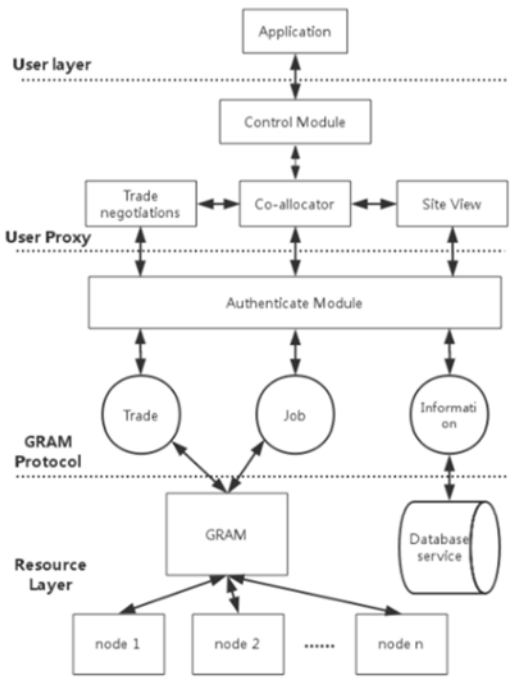

Fig. 2. *Structure of Distribution Resource Integration Model.*

And the process of obtain the distribution resource can described as "User Center--Reception Center--Control Center--Execution Center--Resource management Center "five management, as shown in Figure 3. The distribution resources integration model of agricultural products, determines the basic data and service port on the principle of "unified service, resource sharing and business collaboration" of grid management.

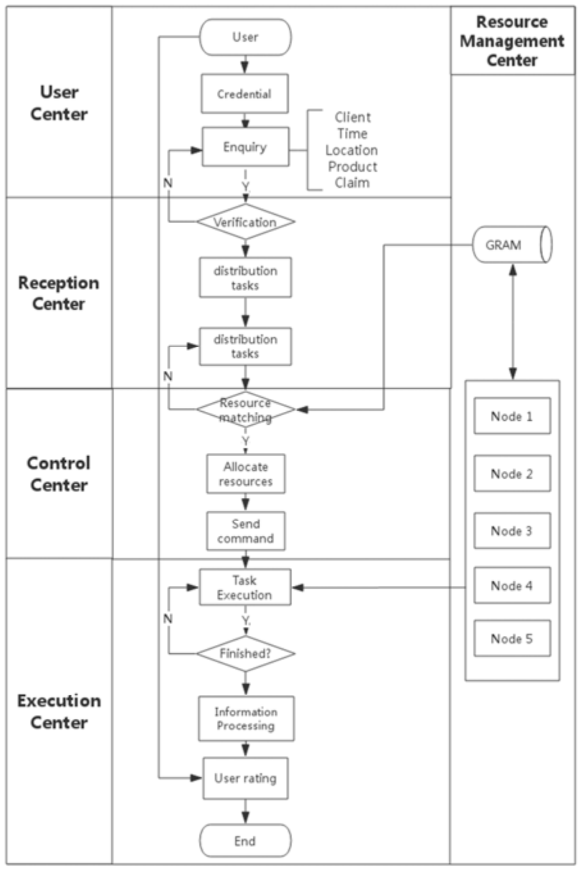

Fig. 3. *Process of Integration Resource Model.*

4. Simulation and Discuss

4.1. Current Situation of Agricultural Products Distribution

Beijing is an oversize agricultural products consumer city, but it has a low self-sufficiency rate of agricultural products, most of which are supplied from other cities. The demand characteristics determine that the current agricultural products logistics in Beijing is a wholesale market-centered model. According to the survey, the wholesale market rate of vegetables has reached 90%. It forecasts Beijing's demand for agricultural products will reach over 8 million tons in 2020 in terms of current data, which makes a higher demand for people's livelihood logistics.

As an advanced delivery model, joint distribution is welcomed in Beijing, since it's capable to integrate social resources, improve logistics distribution efficiency, ease urban traffic and reduce environmental pollution, and to improve the agricultural products logistics in Beijing. So it's meaningful to study how to integrate the distribution resource of agricultural in Beijing.

4.2. Model Simulation

Considering the daily demand of the agricultural product is ever-changing, so we choose three periods to simulate: 1) Peak period: 1.5 million tons; 2) Trough period: 1.0 million tons; 3) Average period: 1.2 million tons. Set vehicles capacity as 1 ton; Set user demand for daily delivery is 1 ton, the number of user is 10,000 per day. The time of system simulation is 28,800 seconds, since the service time is 8 hours per day. The queue service discipline as FIFO(first-in first-out). The process of functioning of the service time is set to a fixed value of 1.Since the speed of information processing is very fast. Taking into account the user login system will encounter problems affect networks and other devices, so when setting submission requirements, the failure rate is set to 5% or 95% probability of successfully submitted. The probability that user can obtain the matching resource from the single logistics information platform (LIP) is 50%. However, the probability to get the available resource is 96% in the model of resource integration (the integrated LIP).

As a comparison, we choose the traditional way to obtain the distribution resource to simulate. We also need discuss the arrival time and the user number before simulation (Table 1-2).

(1) The average arrival time

Table 1. *Average Arrival Time and User Number.*

Period	Total Demand (million tons)	User Number	Arrival Time
1	1.5	15,000	1.92
2	1.2	12,000	2.40
3	1	10,000	2.88

Note: Period 1-3 are peak period, trough period and Average period.

The arrival time is exponential distribution. They are Exponential (0, 1.92, 1), Exponential (0, 2.40, 1), Exponential (0, 2.88, 1) respectively from period 1-3.

(2) The user number of each grid

We divided Beijing into five grids according to the proportion of population. The resource allocation is based on the proportion of the population of each grid. So we can get user number of each grid.

Table 2. *Average Arrival Time and User Number in Simulation-B.*

Period	Total Demand (million tons)	User Number				
		Gird 1	Grid 2	Grid 3	Grid 4	Grid 5
1	1.5	5,400	3,300	1,500	750	4,050
2	1.2	4,320	2,640	1,200	600	3,240
3	1	3,600	2,200	1,000	500	2,700

Note: Period 1-3 are peak period, trough period and Average period.

(I) The process of Simulation-A model：Once the user has the distribution demand, he will search in the Logistics Information Platform (LIP).Since the logistics information platform allocates different access rights to different users to share the corresponding logistics information, there is asymmetry between distribution requirement and the main body of resource supply as well as a certain imbalance between demand and capacity. What’s more, different integrated logistics information platforms (LIP) lack of unified interfaces, so the logistics resource data information from different platforms cannot be shared in a certain format, and users need to log on different platforms. For the sake of simplicity, this paper assumes that if the users still fail to get the required distribution resources after logging on different logistics resources information platforms for four times, it will be regarded as a waiver.

The logic simulation model is shown in Figure 4. And the model parameter design for Simulation-A in FlexSim illustrated in Figure 5.

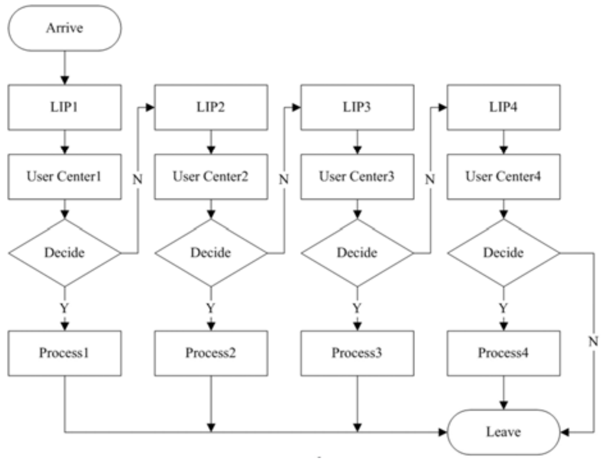

Fig. 4. *Logic Model of Simulation-A.*

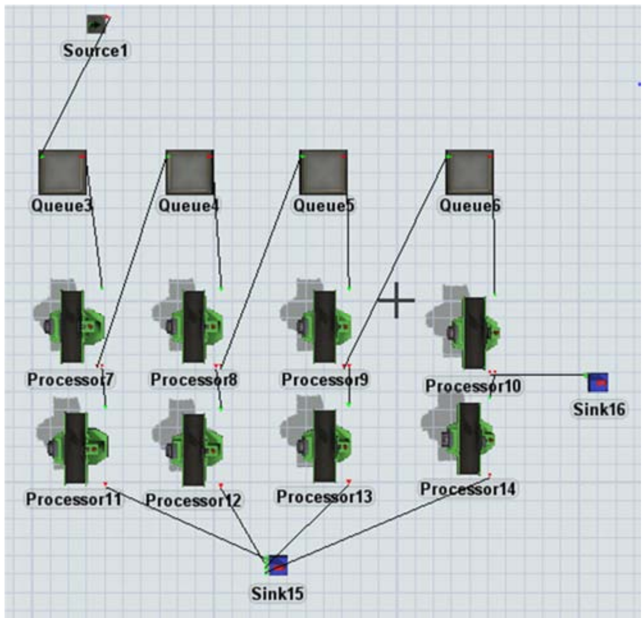

Fig. 5. *Model Parameter Design of Simulation-A.*

(II) The process of Simulation-B model：Once the user has the distribution demand, he will submit the request in the system. in the Logistics Information Platform (LIP). Considering the processing time is fast, so the time of submitting can be ignored to 0, then the system will operate by the computational grid. Reception Center receives the request and sends the corresponding distribution requirements to Control Center. In this case, some failures need take into account, such as security and network hardware and software failures. And we set the failure rate set as 5%, when a network failure occurs, it will be regarded as a waiver. After the standard query of Control Center, if there is adequate distribution of resources, then send the dispatch message to the Resource Management Center (RMC). The Resource Management Center is responsible for Resource allocation and process management based on the request from the last Center. If there is not enough resource for dispatching, the Control Center will send the waiting message to the User Center, and query in the database again or develop a flexible resource allocation and distribution strategies to meet the demand by coordinating the different resource grids.

The logic simulation model is shown in Figure 6. And the model parameter design for Simulation-B in FlexSim illustrated in Figure 7.

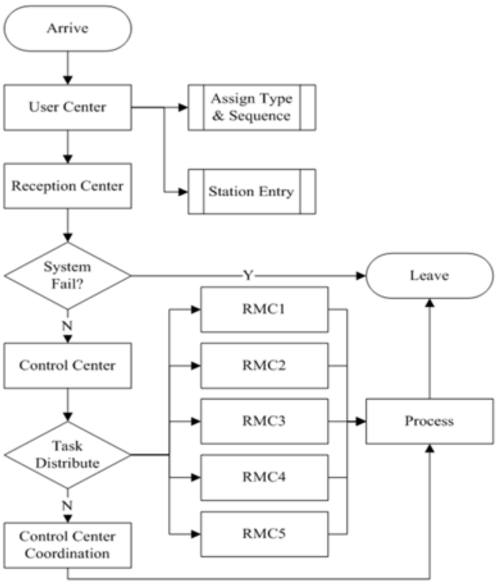

Fig. 6. *Logic Model of Simulation-B.*

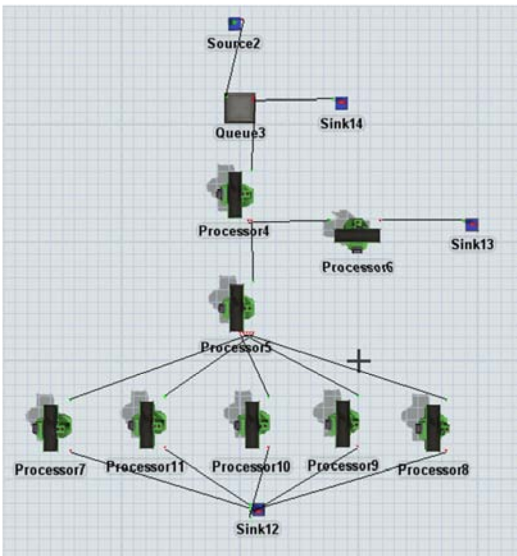

Fig. 7. *Model Parameter Design of Simulation-B.*

4.3. Simulation Analysis

After the simulation, we can analysis the data collected by Reports and Statistics in them FlexSim, so we can compare the simulation results in the aspects of the following evaluation criteria:

(1) The queue length and waiting time

Queueing theory is generally considered a branch of operations research because the results are often used when evaluating about the resources needed to provide a service. So a model is constructed so that queue lengths and waiting time can be predicted and compared according to queueing theory.

The queue length is the expected number of the customer who is waiting for service in the system at any time; and waiting time is the expected waiting time of customer entered the system at any time. We can get the conclusion from Figure 8 that the queue length and waiting time of Simulation-B is shorter than Simulation-A, which means the service responsiveness of Simulation-B is much better than Simulation-A. In other words, the integration model by gird management to integrate agricultural product distribution resources is effective than the traditional way to integrate resource.

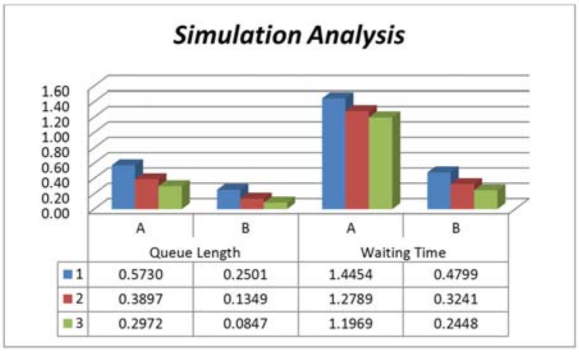

Fig. 8. *Simulation Analysis-1.*

(2) Resource Utilization

The resource utilization is ratio of the number of busy resources and the average number of available resources in the running process, which can evaluate the effectiveness of integration model. The Figure 9 indicates that the level of resource utilization of Simulation-B has been much higher than Simulation-A in three periods. However there are still many idle resources, and the resource utilization has not up to 50%, which should be adjusted through parameters such as resource allocation limit and task allocation proportion for further improvement and optimization of models.

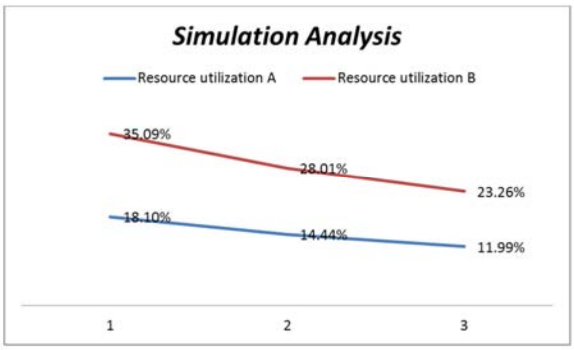

Fig. 9. *Simulation Analysis-2.*

5. Conclusion and Future Research

We proposed a new way to integrate the distribution resource based on the grid management, which is an important integrate model for the government to pay attention to the Joint Distribution for agricultural product and the "vegetable basket" project. And we put the model into practice of Beijing by simulation. The simulation results indicate that service responsiveness and the resource utilization can be much improved through the model. It also provides a theoretical basis for the government to improve the urban distribution of agricultural products to develop operational programs. As for the government, because of the agricultural products is closely related to urban consumer life, and itself has the characteristic of perishable, government should introduce some preferential policies to guarantee a smooth distribution of agricultural products, enhanced support, guidance and supervision and management from the policy level.

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